A Cross Validation Study of STN targeting on MRI: from Stereotactic Procedures and Automatic Registration Algorithms to direct identification.

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Background and purpose
Subthalamic nucleus (STN) Deep brain stimulation (DBS) has demonstrated its efficacy in the treatment of Parkinson´s disease. Accurate targeting of the STN is a crucial step for the success of DBS surgery. MRI has shown to be reliable and allows direct targeting. Unfortunately, STN is not always clearly identifiable on standard T2-weighted images. In these situations, manual targeting procedures represent only an estimation of the real STN position. Recently, registration algorithms have been developed to automatically estimate the position of brain structures from segmented electronic atlases. However, their precision remains to be studied. We propose to evaluate the performance of different targeting methods (manual and automatic) compared to expert accuracy.

Material and Methods:
Position of 16 STN was assessed independently by 2 experts IR-T2-weighted MRI where STN were clearly identifiable (real target: RT). The RT coordinates were reported on the corresponding 3D T1-weighted images. The most clearly visible STN was considered as reference (atlas). Estimation of the target (ET) was performed on T1-weighted MRI using Schaltenbrand and Wahren atlas coordinates (AC-PC), as well as affine and non rigid algorithms (demons, B-splines, segmentation-based) applied on the atlas. Euclidian distances (ED) from ET to RT were calculated and compared to the expert variability using ANOVA test.

Results:
ED were: **AC-PC** 1.96 ± 0.90mm, **Affine** 2.42 ± 0.84mm**, Demons** 1.77 ± 0.65mm, **B-splines** 1.72 ± 0.48 mm, **Segmentation-based** 1.55 ± 0.73mm. No statistical difference was noticed between segmentation-based algorithm and expert variability.

Conclusions:
Segmentation-based algorithm provides similar accuracy as experts to estimate the position of the STN on MRI.